

# **Exhibit C**

## **Part 2**

# Noise Covariance Matrices

- Marvell's assertion that CMU's construction covers “*any* noise statistics” is based on improperly truncating CMU's complete proposed construction

## CMU's PROPOSED CONSTRUCTION

“Noise covariance matrices” means “noise statistics used to calculate the ‘correlation-sensitive branch metrics.’”

- The “noise statistics” of CMU's construction are only those noise statistics that can be used to “calculate the correlation sensitive branch metrics”

'839 Patent at 2:15-20; 2:43-47; 3:30-44;  
col. 5:48-55; col. 6:36-col. 8:27; col. 9:21-39;  
Figs. 3A-3B.

# Noise Covariance Matrices

- It is ***impossible*** to “calculate correlation sensitive branch metrics” with Euclidian branch metric function



**'839 Patent**

Euclidian branch metric. In the simplest case, the noise samples are realizations of independent identically distributed Gaussian random variables with zero mean and variance  $\sigma^2$ . This is a white Gaussian noise assumption. This implies that the correlation distance is  $L=0$  and that the noise pdf's have the same form for all noise samples. The total ISI length is assumed to be  $K=K_l+K_t+1$ , where  $K_l$  and  $K_t$  are the leading and trailing ISI lengths, respectively. The conditional signal pdfs are factored as

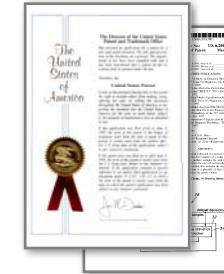
'839 Patent at col. 5:59-67.

# Noise Covariance Matrices

- Marvel's reliance on Intamin is misplaced
  - All of the embodiments of the CMU patents for adapting the noise statistics are described in terms of "noise covariance matrices"
    - Figs. 3A and 3B are linked to Fig. 13
    - The noise statistics, which can be determined in different ways as described at col. 8 of the '839 Patent, are used by the circuits of Fig. 3A and 3B
  - Some of the claims do not require updating "noise covariance matrices"
    - See e.g., claims 27-28 of the '839 Patent
    - Not all of the claims read on the "noise covariance matrices" embodiments, but the "noise covariance matrices" claims read on the different ways of adapting the noise statistics

# Noise Covariance Matrices

- Marvell's reference to claims 20, 21 and 26 of the '839 Patent is irrelevant
- Marvell is ***conflating the circuits used to compute the correlation sensitive branch metrics with the data that is used by those circuits*** – e.g. the “noise statistics”
- None of the claims that require “noise covariance matrices” call out a specific form of “branch metric computation circuit”



**'839 Patent**

20. A branch metric computation circuit for generating a branch weight for branches of a trellis for a Viterbi-like detector, wherein the detector is used in a system having Gaussian noise, comprising:

- a logarithmic circuit having for each branch an input responsive to a branch address and an output;
- a plurality of arithmetic circuits each having a first input responsive to a plurality of signal samples, a second input responsive to a plurality of target response values, and an output, wherein each of the arithmetic circuits corresponds to each of the branches;
- a sum circuit having for each branch a first input responsive to said output of said logarithmic circuit, a second input responsive to said output of said arithmetic circuit, and an output.

21. The circuit of claim 20 wherein said branch metric computation circuit is a tapped-delay line circuit with adaptive weight.

'839 Patent at col. 16:1-19.

# Noise Covariance Matrices

- CMU's construction does not include the "mean signal values"
  - Marvell's reliance on col. 8:24-27 proves CMU's point
  - The term used in Marvell's citation is "signal statistics" not "noise statistics"
    - The specification makes clear that the phrase signal statistics includes more than the "covariance matrices" – also includes the "mean signal values" (the "target" or "ideal" values from the technology tutorial)



'839 Patent

Computing the branch metrics in (10) or (13) requires knowledge of the signal statistics. These statistics are the mean signal values  $m_i$  in (12) as well as the covariance matrices  $C_i$  in (13). In magnetic recording systems, these

'839 Patent at col. 8:24-27.

circuit 32. A noise statistics tracker circuit 34 uses the delayed samples and detector decisions to update the noise statistics, i.e., to update the noise covariance matrices. A

'839 Patent at col. 3:36-38.

# Noise Covariance Matrices

- In light of –
  - The express definition of “noise covariance matrices” in the patent
  - Marvell’s acknowledgement that the patent discloses methods of computing the correlation sensitive branch metrics without computing a “correlation” or using a “covariance matrix” per Marvell’s construction
- There is no basis to exclude any of the disclosed embodiments for adapting the noise statistics from the coverage of the “noise covariance matrices” claims

## The “Signal-Dependent” Terms

- *Signal-Dependent Noise*
- *Signal-Dependent Branch Metric Function*

# “Signal-Dependent” Terms

## DISPUTED CLAIM TERMS

### Signal-Dependant Noise

'839 Patent Claims 2, 5 & '180 Patent Claim 1

#### CMU's PROPOSED CONSTRUCTION

“Signal-dependent noise” means  
“media noise in the readback signal  
whose noise structure is attributable  
to a specific sequence of symbols  
(e.g., written symbols).”

'839 Patent at col. 1:38-51; col. 2:9-20;  
col. 4:24-27; col. 5:48-54; col. 10:18-19.

#### MARVELL's PROPOSED CONSTRUCTION

“Signal-dependent noise” means  
“noise that is dependent on the signal.”

'839 Patent, at 2:18-20; 4:24-27; 5:45-55; 6:35-39;  
cls. 2, 5; '180 Patent, cl. 1. '839 File History,  
March 10, 2000 Office Action and Response thereto.

# “Signal-Dependent” Terms

## DISPUTED CLAIM TERMS

### Signal-Dependant Branch Metric Function

'839 Patent Claims 3, 4 & '180 Patent Claim 2

#### CMU's PROPOSED CONSTRUCTION

“Signal-dependent branch metric function” means “a ‘branch metric function’ that accounts for the signal-dependent structure of the media noise.”

#### MARVELL's PROPOSED CONSTRUCTION

“Signal-dependent branch metric function” means “a ‘branch metric function’ that accounts for ‘signal-dependent noise.’”

'839 Patent at col. 1:38-51; col. 2:9-20; col. 5:48-55; col. 6:14 to col. 7:60.

'839 Patent at 5:48-55; cls. 3, 4; '180 Patent at '180 cl. 2; '839 File History, March 10, 2000 Office Action and Response thereto.

# “Signal-Dependent” Terms

- Why construing these terms matters
  - Marvell's construction appears to be aimed at supporting its invalidity contentions by allowing Marvell to reference prior art that does not take into account the pattern recorded on the media

# “Signal-Dependent” Terms

- The “signal-dependent” claim terms appear in asserted claims and 2, 3, 4, and 5 of ’839 Patent and asserted claims 1 and 2 of the ’180 Patent
  - Claims 1 and 2 of the ’180 Patent are representative



**'180 Patent**

1. A method of determining branch metric values in a detector, comprising:
  - receiving a plurality of time variant signal samples, the signal samples having one of signal-dependent noise, correlated noise, and both signal dependent and correlated noise associated therewith;
  - selecting a branch metric function at a certain time index;
  - and
  - applying the selected function to the signal samples to determine the metric values.
2. The method of claim 1, wherein the branch metric function is selected from a set of signal-dependent branch metric functions.

'180 Patent at col. 15:39-51.

# “Signal-Dependent” Terms

- CMU’s construction comes directly from a description of “the invention” found at the beginning of the ’839 Patent
- The Federal Circuit has repeatedly used statements concerning “the invention” from the Summary of the Invention to construe claim terms

See, e.g. *Microsoft Corp. v. Multi-Tech Sys.*, 357 F.3d 1340, 1348 (Fed. Cir. 2004).



## ’839 Patent

### SUMMARY OF THE INVENTION

In high density magnetic recording, noise samples corresponding to adjacent signal samples are heavily correlated as a result of front-end equalizers, media noise, and signal nonlinearities combined with nonlinear filters to cancel them. This correlation deteriorates significantly the performance of detectors at high densities.

The trellis/tree branch metric computation of the present invention is correlation-sensitive, being both signal-dependent and sensitive to correlations between noise samples. This method is termed the correlation-sensitive maximum likelihood sequence detector (CS-MLSD), or simply correlation-sensitive sequence detector (CS-SD).

Because the noise statistics are non-stationary, the noise sensitive branch metrics are adaptively computed by estimating the noise covariance matrices from the read-back data. These covariance matrices are different for each branch of the tree/trellis due to the signal dependent structure of the media noise. Because the channel characteristics in magnetic recording vary from track to track, these matrices are tracked on-the-fly, recursively using past samples and previously made detector decisions.

# “Signal-Dependent” Terms

- The intrinsic evidence supports CMU’s construction. All citations describe the term “signal-dependent” in relation to the specific sequence of symbols written on the disk



**'839 Patent**

Due to the signal dependent nature of media noise in magnetic recording, the functional form of joint conditional pdf  $f(r_1, \dots, r_N | a_1, \dots, a_N)$  in (1) is different for different symbol sequences  $a_1, \dots, a_N$ . Rather than making this

'839 Patent at col. 4:24-27.

# “Signal-Dependent” Terms

- The intrinsic evidence supports CMU’s construction. All citations describe the term “signal-dependent” in relation to the specific sequence of symbols written on the disk.



**'839 Patent**

$M_i$  represents the branch metric of the trellis/tree in the Viterbi-like algorithm. The metric is a function of the observed samples  $r_i, r_{i+1}, \dots, r_{i+L}$ . It is also dependent on the postulated sequence of written symbols  $a_i-K_1, \dots, a_i+L+K_r$ , which ensures the signal-dependence of the detector. As a consequence, the branch metrics for every branch

'839 Patent at col. 5:48-52.

## “Signal-Dependent” Terms

- Marvell argues that the CMU patent specifications are not limited to magnetic recording channels; therefore, it is improper to define “signal-dependent” in a way that is limited to media noise, since media noise is practically limited to magnetic recording
- Marvell is wrong because:
  - The CMU patents clearly define “signal-dependent” in terms of a pattern (or sequence) of symbols written to the disk
  - Marvell acknowledges that “signal-dependent” is equivalent to “data dependent”
  - Other claims of the CMU patent are not limited to magnetic recording channels or “signal-dependent”
    - See e.g., claims 1,6-10, 20-22, and 27-28 of the '839 Patent

## “Signal-Dependent” Terms

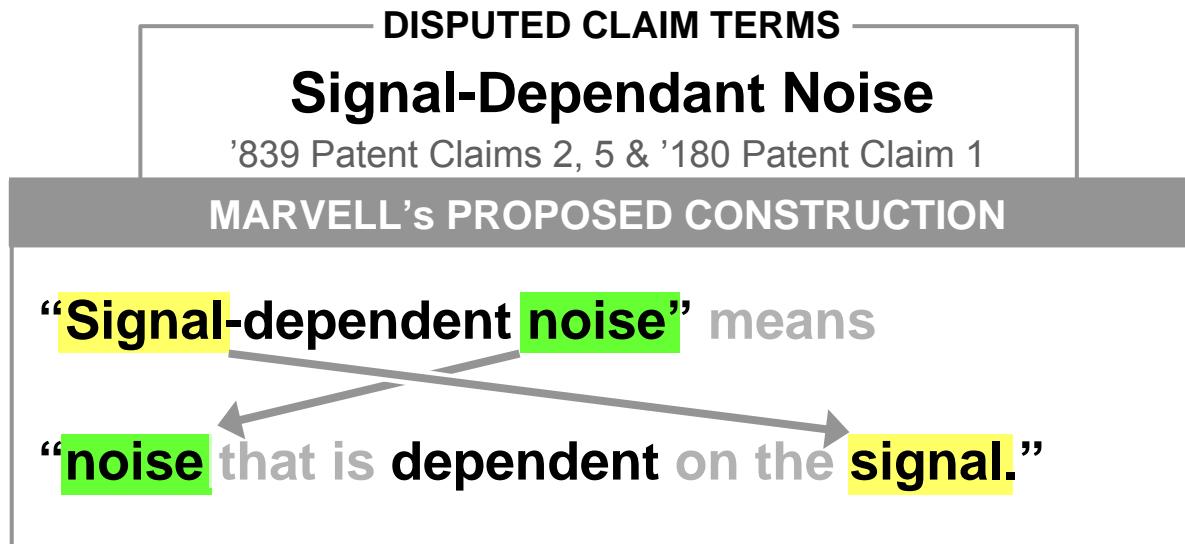
- Marvell did not rebut Dr. McLaughlin’s discussion of the terms “media noise” and “signal-dependent”

26. More media noise is observed near transition regions of the recording layer than near non-transition regions. For that reason, media noise is considered to be pattern (or data or signal) dependent. In other words, the readback signal sample value for a transition (or non-transition) depends on the specific sequence of nearby transitions/non-transitions.

McLaughlin Declaration, 1/27/10, at pg. 9.

# “Signal-Dependent” Terms

- Marvell's construction merely reorders words in the claim term



- Marvell's proposed construction completely ignores the specification

# “Signal-Dependent” Terms

- Marvell’s Opening Claim Construction Brief supports CMU’s construction
  - Marvell equates “signal-dependent noise” with “data dependent noise”

By the early 1990s, researchers had developed detectors to account for the effects of “signal-dependent” noise. See ’839 patent at 1:41-51. For example, in 1992, Prof. Cioffi at Stanford published a paper setting forth a modified Viterbi detector to “cope with data-dependent noise.” I. Lee & J.M. Cioffi, *Performance Analysis of the Modified Maximum*

Marvell’s Opening Claim Construction Brief at pg. 3.

- The “data” are the written symbols recorded on the disk

# “Signal-Dependent” Terms

- Marvell’s Opening Claim Construction Brief supports CMU’s construction

- Assembling Marvell’s admissions, shows that “signal-dependent noise” is noise that is dependent on the particular pattern of data (e.g., symbols) written on the disk

## CMU’s PROPOSED CONSTRUCTION

“Signal-dependent noise” means “media noise in the readback signal whose noise structure is attributable to a specific sequence of symbols (e.g., written symbols).”

'839 Patent at col. 1:38-51; col. 2:9-20; col. 4:24-27; col. 5:48-54; col. 10:18-19.

## “Signal-Dependent” Terms

- Marvell ignores every reference to the phrase “signal dependent” found in the specification
  - Marvell’s claim construction argument is now premised on two extrinsic references and by a misreading of the claims
    - Although resorting to extrinsic evidence in its Surreply, Marvell ignores all of the prior art references to “signal-dependent noise” included in its opening brief

# “Signal-Dependent” Terms

- Marvell's reliance on, e.g. claims 2-5 of the '839 Patent is misplaced and begs the question of what the term “signal-dependent noise” means



## '839 Patent

1. A method of determining branch metric values for branches of a trellis for a Viterbi-like detector, comprising: selecting a branch metric function for each of the branches at a certain time index; and applying each of said selected functions to a plurality of signal samples to determine the metric value corresponding to the branch for which the applied branch metric function was selected, wherein each sample corresponds to a different sampling time instant.
2. The method of claim 1 further comprising the step of receiving said signal samples, said signal samples having signal-dependent noise, correlated noise, or both signal-dependent and correlated noise associated therewith.
3. The method of claim 1 wherein said branch metric functions for each of the branches are selected from a set of signal-dependent branch metric functions.
4. A method of determining branch metric values for branches of a trellis for a Viterbi-like detector, comprising: selecting a branch metric function for each of the branches at a certain time index from a set of signal-dependent branch metric functions; and applying each of said selected functions to a plurality of signal samples to determine the metric value corresponding to the branch for which the applied branch metric function was selected, wherein each sample corresponds to a different sampling time instant.
5. The method of claim 4 further comprising the step of receiving said signal samples, said signal samples having signal-dependent noise, correlated noise, or both signal-dependent and correlated noise associated therewith.

'839 Patent at cols. 13:61-14:23.

# “Signal-Dependent” Terms

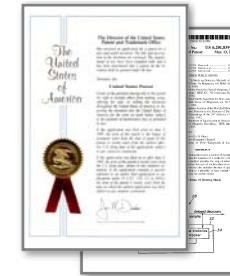
- Marvell's constructions for these terms are illogical
- Marvell's construction for “Signal-Dependent Branch Metric Function”
  - A branch metric function that accounts for “signal-dependent noise”
- Marvell's construction for “Signal-Dependent Noise”
  - Noise that is dependent on the signal

# “Signal-Dependent” Terms

- Marvell’s constructions for these terms are illogical
  - Marvell admits in its brief that “several claims … describe signal samples with signal dependent noise”

Several claims of the asserted patents describe signal samples with signal-dependent noise. '839 patent at claim 2, 5, 18; '180 patent at claim 1, 8. A plain reading of these claims would define “signal-dependent noise” as simply “noise that is dependent on the signal.”<sup>22</sup> The Marvell’s Opening Claim Construction Brief at pg. 34.

- Claim 2 of the '839 Patent provides an example:



'839 Patent

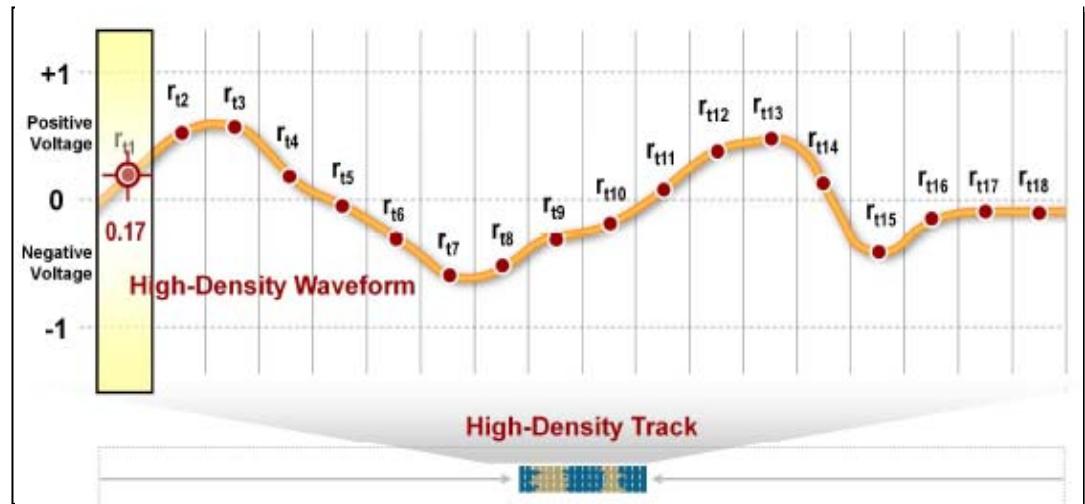
2. The method of claim 1 further comprising the step of receiving said signal samples, said signal samples having signal-dependent noise, correlated noise, or both signal-dependent and correlated noise associated therewith.

'839 Patent at col. 14:3-6.

# “Signal-Dependent” Terms

- Marvell’s constructions for these terms are illogical

- The “signal samples” of the claims are from a “signal” (e.g. the readback signal)



- Marvell’s construction means that the signal samples
  - “**hav[e]...**” signal dependent noise; **and**
  - “**depend on**” signal dependent noise
- Marvell’s construction is akin to saying that the noise **in** the signal samples **is also dependent on** the signal samples.

## “Signal-Dependent” Terms

- CMU's proposed construction was confirmed by Dr. Moura in response to Marvell's deposition questions:

Q. (Mr. Radulescu). What is your understanding of what signal dependence means in the context of magnetic recorders?

MR. GREENSWAG: Objection, asked and answered.

A. (Prof. Moura) So if I go back to the context of our patent, I know how to answer your question.

Q. (Mr. Radulescu). Okay. Please do.

A. (Prof. Moura) Okay. In the context of our patent, what we mean by signal dependence is dependence on the pattern, on the **recorded pattern**. (emphasis added)

Moura Testimony at pg. 43:10-20. (Unofficial transcript)

## The “Viterbi Algorithm” Term

# Viterbi Algorithm

## DISPUTED CLAIM TERMS

### Viterbi Algorithm

'839 Patent Claims 1, 4, 11, 16, 19, 23

#### CMU's PROPOSED CONSTRUCTION

**"Viterbi algorithm"** means "an iterative algorithm that uses a trellis to determine the best sequence of hidden states (in this case, written symbols) based on observed events (in this case, observed readings that represent the written symbols), where the determined sequence is indicated by the best path through the trellis."

'839 Patent at col. 1:24-37; col. 2:49-50; col. 7:5-10; col. 10:26-52; Figs. 4-5; '839 File History, March 10, 2000 Office Action and Response thereto.  
Plaintiff Carnegie Mellon University's Claim Construction Reply Brief at pp. 9-10, n. 13.

#### MARVELL's PROPOSED CONSTRUCTION

**"Viterbi Algorithm"** means "an algorithm that uses a trellis to perform sequence detection by calculating branch metrics for each branch of the trellis, comparing the accumulated branch metrics for extensions of retained paths leading to each node of the trellis at a given time, and for each node, retaining only the path having the best accumulated metric."

'839 Patent, at cols. 1 and 5. '839 File History, March 10, 2000 Office Action and Response thereto; Cited Art, including U.S. Patent Nos. 5,784,415; 5,781,590; 5,689,532; 5,920,599; 5,914,988.

# Viterbi Algorithm

- Why construing this term matters
  - UNCLEAR – this is not a claim term
    - Critical question is whether in the face of the intrinsic evidence Marvell intends to assert that a “Viterbi-like” detector must compute a branch metric for each and every branch of each state of the trellis
    - While the Federal Circuit has made it clear that this Court can construe claims throughout the case, *O2 Micro Int'l Ltd. V. Beyond Innovation Tech. Co.*, 521 F.3d 1351, 1360 (Fed. Cir. 2008), we would like to avoid the disruption of a piecemeal construction
  - CMU is entitled to know now whether Marvell intends to raise an issue concerning whether a “Viterbi-like” detector must compute a branch metric value for each and every branch of each state of a Viterbi trellis

# Viterbi Algorithm

- Why construing this term matters
  - In its tutorial, Marvell seems to be shifting positions
  - The parties' competing constructions are for the term “Viterbi algorithm”
  - Marvell’s technology tutorial creates the impression that the Court is being asked to construe the term “Viterbi” without any mention of the “-like” component of this term

Marvell’s Technology  
Tutorial, slides 91, 96.

## Group II: '839 Patent Claim 16

16. A method of detecting a sequence that exploits the correlation between adjacent signal samples for adaptively detecting a sequence of symbols through a communications channel having intersymbol interference, comprising the steps of:  
(a) performing a Viterbi-like sequence detection on a plurality of signal samples using a plurality of correlation sensitive branch metrics;  
(b) outputting a delayed decision on the transmitted symbol;  
(c) outputting a delayed signal sample;  
(d) adaptively updating a plurality of noise covariance matrices in response to said delayed signal samples and said delayed decisions;  
(e) recalculating said plurality of correlation-sensitive branch metrics from said noise covariance matrices using subsequent signal samples; and  
(f) repeating steps (a)-(e) for every new signal sample.

## Group I: '839 Patent Claim 4

4. A method of determining branch metric values for branches of a trellis for a Viterbi-like detector, comprising:  
[1] selecting a branch metric function for each of the branches at a certain time index from a set of signal-dependent branch metric functions; and  
[2] applying each of said selected functions to a plurality of signal samples to determine the metric value corresponding to the branch for which the applied branch metric function was selected, wherein each sample corresponds to a different sampling time instant.

# Viterbi Algorithm

- “Viterbi Algorithm” **NEVER** appears in the claims

- The claim term is “Viterbi-like” (see, e.g. claim 1)

1. A method of determining branch metric values for branches of a trellis for a Virterbi-like detector, comprising:

'839 Patent at col. 13:61-62.

- The parties stipulated to a construction for this term

Viterbi-like	839 cls. 1, 4, 11, 16, 19, 23	“Viterbi-like” means “similar to and including the ‘Viterbi algorithm.’”
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Joint Agreed and Disputed Claim Terms, Ex. A at pg. 3.

- This term only appears in the specification in the title to a piece of prior art

## OTHER PUBLICATIONS

Zeng et al., “Modified Viterbi Algorithm for Jitter-dominant 1-D<sup>2</sup> Channel,” IEEE Trans. On Magnetics, vol. 28, No. 5, pp. 2895–97, Sep. 1992.

'839 Patent at pg 1.

# Viterbi Algorithm

- CMU's construction for Viterbi algorithm is correct
  - There is one definition of this term in the "intrinsic evidence" found in the Fitzpatrick '532 Patent



'532 Patent

The standard approach to implementing a Viterbi detector is to use the Viterbi algorithm to minimize the squared Euclidean distance between the sequence of noisy samples and all possible sequences of noiseless samples. The Viterbi algorithm is an iterative algorithm for determining the minimum metric path through a trellis, where the metric in this case is the squared Euclidean distance. During each

'532 Patent at col. 2:32-37.

# Viterbi Algorithm

- Marvell also relies on the Fitzpatrick '532 Patent, but is quoting from the "Detailed Description Of A Preferred Embodiment"
- The portion of Fitzpatrick relied upon by Marvell is Fitzpatrick's particular implementation of a Viterbi algorithm, not a general definition.



'532 Patent

## DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

distributed Gaussian noise with zero mean. The Viterbi algorithm is an iterative process of keeping track of the path with the smallest accumulated metric leading to each state in the trellis. The metrics of all of the paths leading into a particular state are calculated and compared. Then, the path with the smallest metric is selected as the survivor path. In this manner all paths which can not be part of the minimum metric path through the trellis are systematically eliminated.

'532 Patent at cols. 7:33-34; 7:64-8:4.

# Viterbi Algorithm

- CMU's definition comes from the section of the Fitzpatrick '532 Patent that discusses several types of Viterbi detectors, ***including detectors that use a reduced state trellis relative to the “standard approach”***
- “The Fitzpatrick '532 Patent discusses the “***standard approach*** to implementing a Viterbi detector...”
- Marvell ignores this language in its brief and supporting citations



## '532 Patent

The standard approach to implementing a Viterbi detector is to use the Viterbi algorithm to minimize the squared Euclidean distance between the sequence of noisy samples and all possible sequences of noiseless samples. The Viterbi algorithm is an iterative algorithm for determining the minimum metric path through a trellis, where the metric in this case is the squared Euclidean distance. During each clock cycle, an EPR4 Viterbi detector updates eight state metrics and selects one survivor path for each of the eight states. The survivor path represents the minimum metric path leading to a particular state, and the state metric represents the metric associated with that survivor path. In order to update the eight state metrics, the detector extends the survivor paths to obtain two paths to each state in the next trellis depth. A path metric is obtained by adding a state metric to a branch metric, where the branch metric represents the squared Euclidean distance between the current noisy sample and the noiseless sample associated with the branch. The path metrics associated with the two paths entering each state are compared and the minimum metric path is selected as the survivor path, and the path metric for this path is selected as the new state metric. During each clock cycle, sixteen path metrics are calculated and eight comparisons are performed.

# Viterbi Algorithm

- CMU's definition comes from the section of the Fitzpatrick '532 Patent that discusses several types of Viterbi detectors, ***including reduced state detectors***
- The Fitzpatrick '532 Patent discusses a Viterbi algorithm that works with "eight states"



'532 Patent

or the ideal EPR4 samples. The EPR4 channel has eight states corresponding to the eight possible values of the last three binary input symbols.  $s[n]=\{x[n-3], x[n-2], x[n-1]\}$ . The state transition diagram for the EPR4 channel shows the channel output symbol and the next state associated with all possible combinations of the binary input symbol and the state. The trellis diagram is obtained by adding a time axis

'532 Patent at col. 2:18:24.

# Viterbi Algorithm

- CMU's definition comes from the section of the Fitzpatrick '532 Patent that discusses several types of Viterbi detectors, ***including reduced state detectors***

- The Fitzpatrick '532 Patent also discusses a reduced state Viterbi (one that works with only four (4) states) meaning fewer branch metrics are calculated relative to the "standard" approach



'532 Patent

One way of reducing complexity of an EPR4 Viterbi detector is to use decision feedback to subtract out the last trailing interfering symbol. Using this approach, the number of states in the trellis reduces to four corresponding to the two remaining interfering symbols. The EPR4 equalized

'532 Patent at col. 3:13-17.

# Viterbi Algorithm

- The unrebutted evidence makes clear that the invention of the CMU patents is intended to work with all forms of Viterbi sequence detection systems, including those that compute branch metrics for fewer than all of the states of the trellis



**'839 Patent**

In the derivations of the branch metrics (8), (10) and (13), no assumptions were made on the exact Viterbi-type architecture, that is, the metrics can be applied to any Viterbi-type algorithm such as PRML, FDTs/DF, RAM-RSE, or, MDFE.

'839 Patent at col. 7:5-9.

32. Forney's paper describes that each branch of the trellis is assigned a "length" (or value). However, in the early to mid-1970s, digital circuits often did not have the processing power to compute a branch length (or value) for each branch of the trellis in a sufficiently timely manner for certain applications. Accordingly, subsequent to Forney's paper, engineers developed Viterbi detectors where the branch metric calculations were carried out on fewer than all of the branches of a Viterbi trellis.

# Viterbi Algorithm

- Because “Viterbi-like” sequence detection does not require computing a branch metric for “each” branch for each state of the trellis, having a construction for “Viterbi algorithm” that includes that limitation will only create confusion